Principles of Integrated Weed Management

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Introduction

Integrated Weed Management (IWM) uses all available weed control strategies in the best possible way to manage weed populations. Such strategies include cultural, mechanical and chemical methods of weed control. All these practices are components of an IWM system and none of these control measures on their own can be expected to provide acceptable levels of weed control. Therefore, instead of relying on only one particular method of weed control, an IWM system uses a combination of methods to control weeds. By following the principles of an IWM system we can reduce the use of herbicides and at the same time provide optimum economic returns to the grower.

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Cultural Methods of Weed Control

Crop Rotation

Crop rotation involves alternating different crops in a systematic sequence on the same land. It is an important strategy for developing a sound long-term weed control program. Weeds tend to thrive with crops of similar growth requirements as their own and cultural practices designed to contribute to the crop may also benefit the growth and development of weeds. Monoculture, that is growing the same crop in the same field year after year, results in a build-up of weed species that are adapted to the growing conditions of the crop. When diverse crops are used in a rotation, weed germination and growth cycles are disrupted by variations in cultural practices associated with each crop (tillage, planting dates, crop competition, etc.).

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Field Scouting

Field scouting is a key component of an IWM system. It involves the systematic collection of weed and crop data from the field (weed distribution, growth stage, population, crop stage, etc). The information is used, in the short term, to make immediate weed management decisions to reduce or avoid economic crop loss. In the long term, field scouting is important in evaluating the success or failure of weed management programs

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and for making sound decisions in the future.

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Cover Crops

The inclusion of cover crops such as rye, red clover, buckwheat and oilseed radish or overwintering crops like winter wheat or forages in the cropping system can suppress weed growth. Fast growing crops or crops exhibiting allelopathic properties can also suppress weeds. Highly competitive crops may be grown as short duration "smother" crops within the rotation. Additionally, cover crop residues on the soil surface will suppress weeds by shading and cooling the soil. When choosing a cover crop, consideration should always be given to how the cover crop will affect the succeeding crop.

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Intercropping

Intercropping involves growing a smother crop between rows of the main crop. Intercrops are able to suppress weeds. However, the use of intercropping as a strategy for weed control should be approached carefully. The intercrops can greatly reduce the yields of the main crop if competition for water or nutrients occurs.

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Nitrogen Fertility

Nitrogen fertilizer can affect the competition between crops and weeds and in the subsequent crops. For example, nitrate is known to promote seed germination and seed production in some weed species. Nitrogen fertilization may result in increased weed growth instead of increased crop yield. Selective placement of nitrogen in a band can favour the crop over the weed. Use of legume residues as opposed to chemical nitrogen fertilizer to supplement nitrogen needs of the crop can enhance weed suppression. Legume residues release nitrogen slowly with less stimulation of unwanted weed growth.

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Planting Patterns

Crop population, spatial arrangement and the choice of cultivar (variety) can affect weed growth. For example, studies have shown that narrow row widths and a higher seeding density will reduce the biomass of later-emerging weeds by reducing the amount of light available for weeds located below the crop canopy. Similarly, fast growing cultivars can have a competitive edge over the weeds.

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Tillage System

Tillage systems alter the soil seedbank dynamics and depth of burial of weed seeds. Studies have found that almost 75% of the weed seedbank was concentrated in the upper 5 cm of soil in no-till fields. In the moldboard plow system however, the seedbank is more uniformly distributed over depth. Other conservation tillage systems are intermediate to these two systems.

Weed seedling emergence is often more uniform from shallowly buried weed seeds and may result in better weed control. Weed seeds closer to the soil surface are more likely to be eaten or damaged by insects, animals, other predators and disease causing organisms.

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Critical Period of Weed Control

The critical period of weed control is an important concept in IWM systems. This period has been defined as an interval in the life cycle of the crop when it must be kept weed-free to prevent yield loss.

This concept helps in determining the most effective time for non-residual postemergent herbicide applications, and reduces the practice of season-long residual herbicides, and unnecessary late applications of herbicides. The critical periods are defined relative to a crop growth stage to account for soil, weather and seasonal variations. The critical period is based on a yield loss of less than 5% due to weed interference. In other words, the crop has to be weed-free during these stages to prevent a yield loss of more than 5%.

If weeds have been controlled throughout the critical period, the weeds that emerge later will not affect yield and can be controlled prior to harvest with a harvest aid to burn down the weeds and desiccate the crop.

Critical Periods of Weed Control in Field Crops	
Crop	Critical Period for Weed Control
Corn	3rd to 8th leaf
Soybeans	1st to 3rd trifoliate
White Beans	2nd trifoliate to first flower

The critical period can vary depending on weather and growing conditions. Some research with corn and soybeans has indicated that the critical period may vary with soil type and tillage system and where the end of the critical period may be extended slightly later on clay soils or when using no-till tillage systems.

Corn: The critical period extends from 3 to 8-leaf stage (4 to 10-leaf tip showing in the whorl, or V2 to V6). Excellent weed control must be maintained throughout this critical period. Corn kept weed-free for approximately 34 days after planting (DAP) or until 6 to 8 leaf stage (8-10 leaf tips) had a yield loss of 0 to 5% under conditions of heavy weed pressure.

Soybeans: The critical period extends from the 1st to the 3rd trifoliate stage of soybean growth (V2 to V3). Soybeans kept weed-free for approximately 15 days after crop emergence had a yield loss of 0 to 5%.

White beans: The critical period extends from the 2nd trifoliate to the 1st flower (V3 to R1) stage of whitebean (approximately 45 days after planting).

Horticultural crops are very sensitive to weed competition, and need to be kept weed free from planting, emergence or budbreak, until the end of their Critical Weed-free Period. This differs slightly from the Critical Period for Weed Control, but is useful for crops where soil applied preemergent herbicides or cultivation are the main option for controlling weeds. If the crop is kept weed free for the Critical Weed-free Period, generally no yield reduction should result. Again, weeds emerging after the critical weed-free period will not affect yield, but control efforts after this time may make harvest more efficient, or reduce weed problems in subsequent years in perennial crops.

Critical Weed-free Period for Horticultural Crops	
Crop	**Critical Weed-free Period**
Apples, new plantings	During May and June
Apples, bearing	Budbreak until 30 days after bloom
Beets	First 2-4 weeks after emergence
Cabbage, early	First 3 weeks after planting
Carrots	First 3-6 weeks after emergence
Cucumbers, pickling	First 4 weeks after seeding
Lettuce	First 3 weeks after planting
Onions	First the whole season
Potatoes	First 4 weeks after planting
Squash	Early plantings compete better
Strawberries, new	During May and June
Tomatoes, fresh	First 36 days after transplanting
Tomatoes, seeded	First 9 weeks after seeding

Season-long weed control is not necessary!

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Alternative methods of weed control are available for all tillage systems. Studies have shown that banding herbicides will increase profitability. For example, selective application of herbicides in 30 cm bands on 76 cm wide corn rows represented an approximate 60% reduction in total herbicide applied into the environment. When complemented with inter-row cultivation, weed control and crop yields were maintained with lower herbicide costs.

Economic Thresholds

Weed economic thresholds help in determining if weed density and interference is sufficient to justify control measures, i.e., if the yield loss avoided is greater than the cost of weed control. The time at which weeds emerge relative to the crop is a major determinant of yield loss. Early weeds that emerge at the same time as the crop cause more yield loss than weeds emerging after the crop is established. For example, economic threshold studies conducted with redroot pigweed, ragweed and barnyardgrass have found that the time of weed emergence in relation to the crop stage is more important than weed density when evaluating weed control options. Crop yield loss depends on the relative time of weed seedling emergence.

Corn: Corn tolerated a weed density of 4 plants/m of row when redroot pigweed emerged at the 6th leaf stage of corn, but only 0.5 plants/m when they emerged at the 3rd leaf stage of corn.

Soybean: Soybeans tolerated a weed density of 4-8 plants/m when redroot pigweed emerged at the unifoliate stage of the crop but only 0.5 plants/m of row when they emerged with the crop.

White bean: White beans tolerated a ragweed density of only 0.5 plants/m of row when the ragweed emerged with the crop, but 4 plants/m of row when the ragweed emerged at the 2nd trifoliate stage of the crop. The weed densities were based on a threshold of 5%. For example, a grower scouts his/her white bean field and finds ragweed plants emerging at an average density of 4 plants/m of row, at the 2nd trifoliate stage of crop growth. Expected yield losses would be approximately 5%. Then based on his expected yield estimate, the

yield loss in dollars can be estimated based on current market value. If the yield loss is $20/acre and the herbicide application will cost $25/acre, then do not spray.

Critical periods and economic thresholds however do not apply in the same way to weeds, such as black nightshade, which may reduce the quality of the crop. In such cases the economic threshold may be zero.

Crop yield loss depends on the relative time of weed seedling emergence.

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From OMAFRA Publication 75, Guide to Weed Control

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